varied from .00013 mm to .00026 mm in diameter. The thickness of the water film was probably .0014 mm. He compares these with the diameters of fog particles measured by Barus in his experiments on atmospheric nucleation. He also treats of the sources of solid particles in London fogs. These come quickly, the air being relatively clean at 6 a.m.; and heavily laden with smoke fog by 9 a.m. When the air in London is fairly clear in winter, the amount of suspended matter is approximately 1 milligram per cubic meter; during a dense fog it rises to 5 mgs/m^3. A rough estimate of the weight of the impurity in a fog for an area of 310 square kilometers (120 square miles) and a height of 122 meters gives 193 tons. According to Dr. Owens the amount of smoke produced between 6 a.m. and 10 a.m. from domestic fires and factories is sufficient to account for this load of suspended matter over London on a foggy day at 10 a.m.

Dr. Owens touches on the amount of dust in expired air. It has been assumed by medical men that the air passage through nose and throat practically trapped all the solid impurities. He doubts this and some experiments which he made seem to prove that in ordinary breathing the expired air contained about 70 per cent. of the suspended impurity which entered during inspiration. It seems certain that suspended matter is not entirely removed by action of the respiratory passages. In fact, only about 30 per cent. is removed.

Quite a good deal of space is given to a discussion of the relation of visibility to suspended impurity. The discussion is technical and no definite conclusions are reached.

Research work on measurements of acidity in the suspended matter of air is in progress.

ALEXANDER MCADIE

SPECIAL ARTICLES

STUDIES OF THE POLLEN TUBES AND ABORTIVE OVULES OF THE GLOBE MUTANT OF DATURA

THE Globe mutant, like the twelve or more other ($2n+1$) mutants already described (1 and 3), owes its mutant character to the presence of a single extra chromosome, the somatic number being 25 instead of 24. One of us (2) has shown by means of breeding tests that the inheritance of Globes is almost exclusively through the ovules, by which it is transmitted to only one quarter of the offspring whether the parent Globe is selfed or is pollinated by a normal diploid. Pollen from a Globe when applied to stigmas of a normal parent transmits the Globe complex to considerably less than 3 per cent. of the offspring.

Our colleague, Mr. Belling, finds that half of the pollen grains of Globe plants receive the extra chromosome. The fact that some of the ovules transmit the character, while some give rise to normal plants, indicates that a similar segregation takes place in the formation of the ovules. While the back-cross of Globes x normal pollen does not produce more than about one quarter Globes in the offspring, there are more than enough small aborted ovules in the seed pod to account for the missing Globes necessary to satisfy the expected 1:1 ratio of Globes to normals. We may safely infer, therefore, that half of the mature megaspores within the ovules receive the extra chromosome.

If there were no losses through bad pollen or abortion of ovules, the expected result of selfing ($2n+1$) Globes would be 25 per cent. normal diploid plants with the formula $2n$, 50 per cent. ($2n+1$) Globes, and 25 per cent. ($2n+2$) Globes with two extra chromosomes in the Globe set. Instead, we get mostly normals, with only about 25 per cent. ($2n+1$) Globes and but rarely a ($2n+2$) Globe.

The problem here is to find if possible exactly where the losses are incurred, whether in pollen grains which fail to germinate, in pollen tubes which fail to grow fast enough to reach the ovary, or which fail to fertilize the ovules, or entirely in zygotes which are lost in the aborted ovules.

Aborted ovules were counted in seed pods that were nearly ripe. These can be seen with a hand lens or binocular dissecting microscope on the enlarged fleshy portion of the placentæ among the seeds.

Two classes of aborted ovules were recognized, the tiny apparently unenlarged ovules and those that were distinctly enlarged. The

enlarged ovules were doubtless fertilized while the tiny ovules which were probably but not certainly fertilized were counted as fertilized when they were located among the enlarged ovules and seeds.

Counts of the aborted ovules in well filled seed capsules resulting from abundant hand pollinations were as follows:

A. Normal x Normal, 6-9 per cent. (exact average for 5 capsules was 7.6).

B. Normal x Globe, 10-15 per cent. (exact average for 5 capsules was 12.8).

C. Globe x Normal, 22-34 per cent. (exact average for 5 capsules was 29.5).

D. Globe x Globe, 35-50 per cent. (exact average for 4 capsules was 39.4).

Since the Globe character is transmitted through the pollen parent in less than 3 per cent of the seeds, the discrepancy in the number of abortive ovules between A and B as well as between C and D suggests that 4-10 per cent. of the $(n+1)$ pollen tubes enter the ovary. More extensive studies will be needed to justify this tentative conclusion but the data at hand seems to indicate this and that there is a much greater mortality of Globe zygotes than of normals in embryonic development.

The style of Datura, as in many angiosperms, contains a central core of conducting tissue which is soft and fibrous, made up of narrow linear shaped cells, extending lengthwise of the style and terminating in the stigma where these cells become papillate. The pollen tubes, aided by a process of digestion grow down to the ovary through this tissue.

For a study of the pollen tubes, receptive stigmas were pollinated with a single layer of pollen in order to insure opportunity for uniform germination. This was done by applying the pollen in moderate quantities and blowing off the excess which was not immediately held by the stigmatic fluid. The styles were removed after a given period of time, scalded in hot but not boiling water (about two minutes) their cortex slit lengthwise by passing them through a groove in which the sharp corner of a fragment of a razor blade protruded slightly. This treatment facilitated the removal of the cortical tissue by dissection, leaving only the central strand of conducting tissue with which the stigma is continuous at the end. These central cores were stained in magenta (acid red), washed a little in water and mounted whole on a slide using concentrated lactic acid as a mounting medium and clearing agent. Balsam mounts were not found satisfactory but these lactic acid preparations have kept for more than six months.

Pressure applied to the cover glass will spread this tissue out in a thin layer, and the pollen tubes may be seen even under low power (better after 12-24 hours) as dark red streaks imbedded among the elongated pink-stained cells of the conducting tissue. Germinated pollen grains are transparent and may be recognized only by their empty shells (the exine walls) while the ungerminated pollen grains will stain a deep red. This method makes possible reliable counts of the number of ungerminated pollen grains and the num-

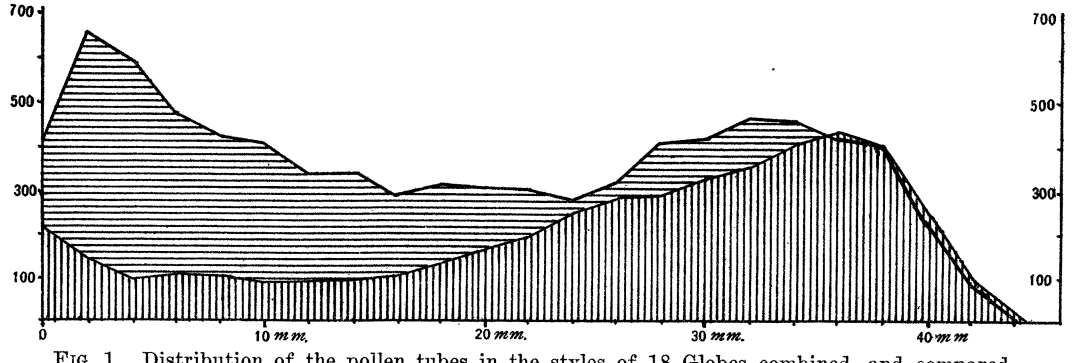

FIG. 1. Distribution of the pollen tubes in the styles of 18 Globes combined, and compared with 11 normals. Stigma is at left and the pollen tubes were growing to the right. Values plotted at O distance represent the ungerminated pollen grains.

ber of pollen tubes in various portions of the style at any given time after pollination.

Though a lateral displacement of the pollen tubes results from the flattening of these strands of conducting tissue, every pollen tube is practically in place with reference to its distance from the stigma or ovary. By means of a microscope equipped with a mechanical stage it was found possible to count their number and measure their distance from the end of the stigma, down as far as they had penetrated, from which their curves of distribution could be plotted and studied.

In the adjoining diagram the pollen tube distribution curves were made by superposing the pollen tube counts of a dozen or more styles whose foremost pollen tubes had penetrated to about 42 mm. The counts were made for 2mm. intervals and this represents their distribution about fourteen hours after pollination under fairly uniform temperature conditions—approximately 20°C. The bi-modal curve is for Globes selfed and represents a total of 8,365 pollen grains applied to 18 stigmas under similar conditions, while the curve of distribution for selfed normal plants is shown superposed on this and represents 4,691 pollen grains applied to 11 different stigmas. In the normals the germination was 95.6 per cent. while the Globe pollen selfed gave a germination of 94.9 per cent. The curves are much more jagged when the pollen tube populations from individual styles are plotted but those from Globes are quite as characteristically bi-modal.

The explanation offered is that though the Globe pollen selfed germinates about as well as the normal pollen selfed, there are slower growing pollen tubes among the rapidly growing ones and soon this population of gametophytes becomes resolved into two groups which grow at slightly different rates. This bi-modal character increases with time, and the slowest pollen tubes may fail to fertilize because they fail to enter the ovary before abscission of the style, or they may fail only because the ovules were already fertilized by the more rapid pollen tubes. Since the Globe character is only slightly transmitted through the pollen, we infer that the pollen tubes with $(n+1)$ chromosomes are the slow ones, while the tubes with n chromosomes are those in the lead.

While this study is very largely still in its preliminary stages, it seems to show that we have in Datura a selection between gametophytes, one of the special forms of Developmental Selection described by one of us (4), thus proving that this form of selection is subject to experimental study. The result of our preliminary study also shows that the Globe, as well as the other $(2n+1)$ mutants of Datura, illustrates a condition in which the mutations tend to disappear because they are not favored by the processes of Developmental Selection.

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THE MATHEMATICAL ASSOCIATION OF AMERICA

The sixth annual meeting of the Mathematical Association of America was held at the University of Toronto on Thursday and Friday, December 29 and 30, 1921. One hundred and ten were in attendance at the sessions of the association, 88 of these being members of the association. The following papers were read at the meeting aside from the papers by Professors Carmichael, Curtiss and Slaught on the program of the joint sessions with the American Mathematical Society, and Section A of the American Association: